ECCE 2021 Tutorial Proposal 22530

1. Tutorial Title

Printed Circuit Boards in Power Converter Applications: Design Considerations and Failure Mechanisms

2. Instructor Team

Ashish Arora, Exponent
Email: aarora@exponent.com
Phone: 623-587-6790

Yike Hu, Exponent
Email: yhu@exponent.com
Phone: 623-587-6787

3. Abstract

Printed Circuit Boards (PCBs) are the backbone of all electronic circuits and are ubiquitous in today's world in almost all applications. PCBs not only interconnect components through conductors routed through the board with traces and vias, but also provide electrical insulation between conductors of different potentials that are in different circuit nodes. Their use in power converter and energy storage applications gives rise to risks that do not necessarily exist in other lower power applications. While PCB failures are not very common, a propagating PCB failure in a power converter or energy storage application can trigger a cascading series of failures that spread to the system's energy storage component eventually resulting in a fire.

Propagating PCB failures can occur due to a number of reasons such as contamination on the PCB, improper PCB layout or a failure of a component on the PCB itself. Design choices made during the development of a product, the cleanliness of the PCB manufacturing process, the stresses applied to the PCB during a products assembly process etc. can all impact the probability of a PCB failure in the field. Understanding the causes of PCB failures and how these failures can propagate in an application allows for the design and manufacture of systems with more robust PCBs that have a lower probability of a catastrophic failure in the field.

This tutorial will provide an overview of some of the requirements and challenges of designing and manufacturing PCBs specially for power converter and energy storage applications. The tutorial will also provide an overview of the types of PCBs, how PCBs are manufactured, how components get onto the PCBs and the standards that exist to evaluate the PCB manufacturing process. PCB failure mechanisms such as interconnect overheating, contamination, electrochemical migration, dendrite formation and conductive anodic filaments, tin whiskers

and component over-heating will be reviewed. Case studies will provide examples of failures observed in the field and the means to mitigate them.

4. Instructor Bios

Mr. Ashish Arora is a principal engineer at Exponent, an engineering and scientific consulting firm. Mr. Arora specializes in electrical, electronic and computer systems. His professional activities involve design reviews, targeted electrical testing of new systems, field failure analysis, recall-related investigations and product liability issues. He has worked on projects involving power converter and energy storage systems for a variety of applications and has performed both hardware and software design reviews and failure analysis in these systems.

He has also assisted his clients in evaluating and choosing vendors that can produce electrical systems with the required quality and safety on an ongoing basis. He has authored numerous publications on product design reviews and safety evaluations including a book on the subject of Li-ion Battery Failures in Consumer Electronics in 2019.

Dr. Yike Hu is a managing scientist at Exponent, an engineering and scientific consulting firm. Dr. Hu's area of expertise is product safety evaluation and failure analysis of electrical and electronic systems. She has worked extensively on technical investigations in the energy storage systems applications, including hardware level and system level evaluations, circuit design reviews, risk assessments and design failure mode analyses. Dr. Hu has also assisted clients with technology landscaping review regarding technical standards, regulatory requirements and pre-certification preparation for the US, Canada and European market.